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CORN EXPERIMENTS

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It is five years since the Ohio Station has published a bulletin upon its experiments with corn. During this time quite an amount of data bearing upon this subject has accumulated. It is the purpose of this bulletin to gather together this, and older work of the Station, and present the same in a way to turn some light upon the problems confronting the corn grower.

The improvement of our yields of corn will come along two principal lines: the improvement of the plant home, or the soil condition, and the improvement of the plant itself—better varieties and better seed. The possibilities are great along each line, though it is to be expected that the improvement of the soil conditions will afford an opportunity for the greater gain.

Taking up the matter of the conditions of growth, attention is called, first, to the relation of crop rotation to production.

1—ROTATION OF CROPS

For upward of 20 years, now, this Station has been growing corn, both in continuous culture and in a 5-year rotation of corn, oats, wheat, clover and timothy. In the 5-year rotation, clover has been the dominant crop the fourth year, and timothy, the fifth, both being sown together in the wheat.

These experiments were started 21 years ago, on land which had been rented for 25 years previous, and hence badly depleted; land, it should be said, that is not typical corn land. The experiments have been continued without interruption to date.

In order to bring out the tendencies of the two systems the data are grouped in 4 periods of 5 years each.

The outstanding fact in Table I is the greater decline in yield under continuous cropping than under rotation. This will be better appreciated if the first and fourth periods be compared. When no fertilizers have been used the yield, under continuous cropping, has declined 67.8 percent; while in the 5-year rotation the yield has declined 36.3 percent.

Where stable manure has been used the yield has declined nearly 30 percent under continuous culture, even though 56 percent more manure was used during the entire period than under rotation. Despite the smaller application of manure, the yield under rotation increased 37 percent.

TABLE I: Continuous vs. rotation corn. Twenty years work

System	Treatment	Application per acre		Av. yield per acre—Bushels				Average yield for 20 yrs.
		Per crop	Per 5-yrs.	1st period	2nd period	3rd period	4th period	
Continuous....	None..............	....	....	26.26	16.76	10.43	8.44	15.47
Rotation (a)...	None..............	....	....	31.89	30.82	31.04	20.31	28.95
Continuous....	Manure...........	5 tons	25 tons	43.13	40.11	34.62	30.22	37.02
Rotation (a)....	Manure...........	8 tons	16 tons	40.73	49.52	59.75	55.83	51.81
Continuous....	Com. fertilizer ...	250 lbs.	1,250 lbs.	38.86	39.09	28.00	26.83	33.19
Rotation (a)...	Com. fertilizer	320 lbs.	985 lbs.	35.78	49.54	53.91	44.10	46.49
Rotation (b)...	Manure...........	8 tons once in 3 years on corn						60.20 (c)
Rotation (b)...	None..............	Average of 8 unfertilized plots						35.19 (c)

a—5-year rotation
b—3-year rotation
c—Average for 17 years

Where commercial fertilizers have been used as indicated in the table—the larger amount in continuous culture—the yield has declined 30 percent under continuous culture and increased 23 percent under rotation.

The yields under rotation for the fourth period should have a word of explanation. These particular rotation fertilizer experiments suffered very seriously from attacks of the white grub two different seasons. These attacks helped, at least, to reduce the yields during the fourth period, as compared with the third. Whatever else may happen to corn grown in continuous culture it is apparently immune from attacks of the white grub.

For a period of 17 years this Station has been conducting a 3-year rotation of corn, wheat and clover. Attention is called to a plot receiving 8 tons of manure once in 3 years (manure applied to corn) and to the average of the 8 unfertilized plots scattered throughout the test. These data are recorded at the bottom of Table I. The land on which this 3-year rotation test is conducted is quite like that used in the 5-year rotation test and has a similar history. The manured plot in the 3-year rotation receives less manure on the average of a period of years than in the 5-year rotation, yet the 17-year average yield is 60.2 bushels as compared with 51.81 bushels in the 5-year rotation. The unfertilized yield in the 3-year rotation averages 35.19 bushels, as compared with 28.95

bushels in the 5-year rotation. These differences of 8.39 and 6.24 bushels, respectively, may largely be credited to the differences in the rotations. In the 3-year rotation the clover crop comes once in 3, instead of once in 5 years.

2—THE VALUE OF PHOSPHORUS

Experiments have been in progress for the last 20 years which bring out quite forcibly the value of phosphorus in corn production. In one experiment there are a series of plots which have received no manure or other fertilizer for 20 years save 320 lbs. of acid phosphate per acre during each rotation of 5 years. The increase in yield of the several crops of the rotation resulting from its use is worth $16.52 per acre, figuring corn at 40c per bushel, oats at 30c, wheat at 80c, hay at $8.00 per ton, corn stover at $3.00 and straw at $2.00. The acid phosphate at $14.00 per ton, applied to the land, costs $2.24 per acre, leaving a net gain over cost of acid phosphate of $14.28.

This return for the investment is certainly satisfactory, if the yield of corn is not. The latter is only 37.23 bus. per acre, as a 20-year average, the unfertilized yield being 28.95 bus. Manifestly something is needed on the land besides phosphorus. With the addition of either nitrogen or potassium to the above amount of phosphorus the yield of corn is increased to a little over 43 bushels per acre, and by the addition of both, to 47 bushels, though the profit over cost of fertilizer is but a little greater than from phosphorus alone, owing to the high cost of commercial nitrogen and potassium. Cheaper sources of these elements are found in the stable manure. Larger yields of corn have been secured with the use of manure, and substantially as good returns from phosphorus, when used in addition to manure.

The great value of manure in corn growing is further apparent from results recorded in Table II. The manure and phosphatic fertilizers used in the rotation are all applied to the corn crop. The application of 8 tons of stall manure is apparently more than maintaining the yield, as is shown by comparing the yields during the two periods. The average yield during the second period is nearly double that of the unfertilized plots.

The addition of phosphorus to manure increases the yield very materially. Two carriers of phosphorus have been used throughout the test; acid phosphate and raw rock phosphate, commonly called floats. Each carrier has been mixed with the manure before the latter was applied to the land. It will be noted that acid phosphate has led the floats, slightly, and that this lead is widening.

TABLE II: The value of manure and phosphorus. Three-year rotation

Treatment	Plot No.	Pounds per acre	Cost	Av. yield of corn per acre—Bushels		Av. value of increase per acre of all crops of the rotation	
				1st period 1897-1905	2nd period 1906-1913	1st period	2nd period
Stall manure......	16	16,000	....	57.13	64.14	$22.94	$29.21
Stall manure...... / Acid phosphate...	6	16,000 / 320	.... / $2.24	62.28	73.45	37.68	45.49
Stall manure...... / Floats.............	3	16,000 / 320	.... / 1.60	61.97	72.05	35.53	37.42
None .... / Av. 8 unfert. plots.		......	....	36.99	32.87	....	....

In this, as in other fertilizer work of the Station, every third plot is grown without fertilizer treatment of any sort, for the sake of furnishing a yardstick, as it were, at the side of each fertilized plot, with which to measure the gains from the use of the different fertilizers. These unfertilized plots also report any unevenness in the tract of land under experiment and afford a means to correct such differences. Compared in this way with the unfertilized plots between which the above plots were grown, the increases in yield of the several crops of the rotation have been determined and valued at the prices heretofore mentioned, with the results indicated in the final columns of Table II. These figures, representing all the crops of the rotation, bring out more strongly than the corn yields alone the fact that acid phosphate is gaining upon the floats.

It does not necessarily follow that every farm in this state will give a similar return from the use of phosphorus, although on test fields in 9 different counties in the state all save one have given a prompt response to phosphorus.

3—LIME

One of the factors essential to successful corn growing is an abundance of carbonate of lime in the soil. The eastern half of Ohio is relatively deficient in this compound, as compared with the western half, though in many portions of western Ohio, particularly on land which has been under cultivation a long time, lime is now needed. As illustrating the value of lime on land that is needing it badly, attention is called to a series of plots which have been fertilized in different ways for a period of 20 years, portions of which were limed in 1900 and at regular intervals since that date, using, as a rule, one ton of burned lime per acre in the early part of the period and two tons of ground limestone later.

The results of this use of lime, as affecting the corn crop, are recorded in Table III.

TABLE III: The effect of lime on corn, grown on acid soils, and the value of lime to the entire rotation. Average 12 years

Treatment (Fertilizers per acre for one rotation of 5 years)	Plot No.	Yield of corn per acre—Bushels		Gain for lime Bus.	Value per acre of all crops of the rotation		Value of gain for lime per acre for the rotation
		Unlimed	Limed		Unlimed	Limed	
I: Without nitrogen:							
Phosphorus, 20 lbs., in acid phosphate	2	36.13	43.64	7.51	$67.80	$81.80	**$14.00**
Phosphorus, 20 lbs.; potassium, 108 lbs., in muriate of potash	8	43.86	51.68	7.82	76 28	92.33	**16.05**
II: Nitrogen, 38 lbs., with phosphorus, 30 lbs., and potassium, 108 lbs.							
Nitrogen in nitrate of soda	17	48.85	56.29	7.44	87.76	104.49	**16.73**
Nitrogen in sulphate of ammonia	24	45.80	57.68	11.88	80.04	104.14	**24.10**
III: Nitrogen, 76 lbs., in nitrate of soda, with phosphorus, 20 lbs., and potassium, 108 lbs.							
Phosphorus in acid phosphate	11	49.06	55.73	6.67	93.83	103.16	**9.33**
Phosphorus in bone meal	26	45.53	52.99	7.46	87.60	100.90	**13.30**
Phosphorus in basic slag	29	48.71	52.07	3.36	92.36	96.59	**4.23**
IV: Yard manure, 16 tons, estimated to carry nitrogen, 144 lbs.; phosphorus, 48 lbs., and potassium, 112 lbs.	18	56.02	62.71	6.69	99.08	115.05	15.97
Average of unfertilized plots		25.96	34.21	8.25	49.40	61.40	**12.00**

The 12-year average yield of corn is given for both the limed and the unlimed portion of each plot. The significant fact is that no combination of fertilizers used, not even a liberal application of manure, has made it unnecessary to use lime on this land. The nearest approach to it is on plot 29, which receives its phosphorus in the form of basic slag—a product which carries a considerable quantity of lime. While the unlimed yield of the plot is fairly good, it is not quite as good as the unlimed yield from an equal amount of phosphorus in acid phosphate (plot 11), and considerably behind the limed yield of the latter plot. The greatest increase from the use of lime is found in plot 24, which receives its nitrogen in the form of sulphate of ammonia—a product which here, as elsewhere, has exhausted the soil of its lime more rapidly than nitrate of soda. However, when the needed lime is supplied, the yield at once comes to the front. It is important to note that while lime increases the yield of corn on the unfertilized plots slightly more than the average increase from its use on the fertilized plots, when all the crops of the rotation are considered, the effect of lime is greater on the fertilized plots.

The latter half of Table III takes into consideration all of the crops of the rotation, which are valued at the prices previously mentioned.

The full value of the increase due to the use of lime is given in the final columns of the table. This value ranges from $4.23, on plot 29, to $24.10, on plot 24. Plot 18, which receives manure only, gives the largest yields, both with and without lime. The value of the crops produced on this plot without lime is greater than that on 3 of the fertilized plots with lime, and yet plot 18 is increased $15.97 in value by the use of lime.

The cost of the lime has varied quite a little during the period of this test. It has averaged about $5.00 per acre, per rotation. There is therefore but one plot—29—which has not paid a good profit upon the investment in lime.

In tests at the Miami county experiment farm lime has given an increased yield with all the crops of the cereal rotations on the light-colored clay soil, and has been used at a profit, though not with as great profit as at Wooster.

PROPER SOIL CONDITIONS

Proper soil conditions for the corn crop will then include thorough under-drainage, either natural or artificial; a crop rotation which will adequately maintain the organic matter of the soil through the use of good sods of clover and grasses, and such catch-crops as may be adapted to the varying conditions, in addition to all the manure available; liberal applications of phosphorus to supplement the manure and natural deficiencies in the soil, as well as to restore the phosphorus sold from the farm in cereals and livestock; and lime as may be needed to correct soil acidity and furnish a satisfactory environment for bacterial life. In the absence of manure some soils will need applications of nitrogen and potassium before good crop yields can be secured.

4—DEPTH OF PLOWING AND SUBSOILING

In 1910 this Station started a series of experiments in duplicate in which the work of the Spalding deep tilling machine was compared with ordinary plowing, and with ordinary plowing plus subsoiling. The rotation followed in these experiments is corn, oats, wheat and clover. The special plowing has been done for both the corn and wheat. The deep tilling plow has been run at a depth of 15 inches; the ordinary plow, 7½ inches, and the subsoiled plots have had a common subsoil plow run in the bottom of the ordinary furrow an additional 7½ inches. All the plowing for corn has been done in the spring, and for the wheat, from 4 to 6 weeks in advance of seeding.

We are concerned in this bulletin with the effect of this plowing upon corn yields. Five crops of corn have thus far been harvested. The yields recorded in Table IV are the average of two series of plots each year except for 1913. The duplicate series in corn in 1913 gives evidence of being uneven, and consequently only one set of plots figure in the report for this year.

TABLE IV: Deep vs. ordinary plowing

Year	Bushels of shelled corn per acre		
	Ordinary	Spalding	Subsoil
1910	42.13	38.98	42.90
1911	78.49	76.75	79.05
1912	51 08	54.18	47.14
1913	63.20	71.29	74.83
1914*	68.55	64.41	71.15
5-year average	60.69	61.12	63.01

*Ear corn reduced to 15% moisture.

The 5-year average yields show a gain of 2.32 bushels of corn for subsoiling over ordinary plowing, and a gain of 0.43 bushel for

15-inch plowing over 7½ inch. It is evident that in so far as the corn crop is concerned, neither the very deep plowing, nor the subsoiling is a paying operation on the Wooster soil, under the conditions of this test. Both operations add greatly to the labor cost of the plowing, beside calling for a larger investment in implements.

The average results with the other crops of the rotation have been as follows:

Oats, ordinary plowing, 45.49 bushels per acre; deep plowing, 43.80 bushels; subsoiling, 45.11 bushels.

Wheat, ordinary plowing, 32.73 bushels; deep plowing, 33.90 bushels; subsoiling, 34.19 bushels.

Clover, ordinary plowing, 2.43 tons per acre; deep plowing, 2.35 tons; subsoiling, 2.34 tons.

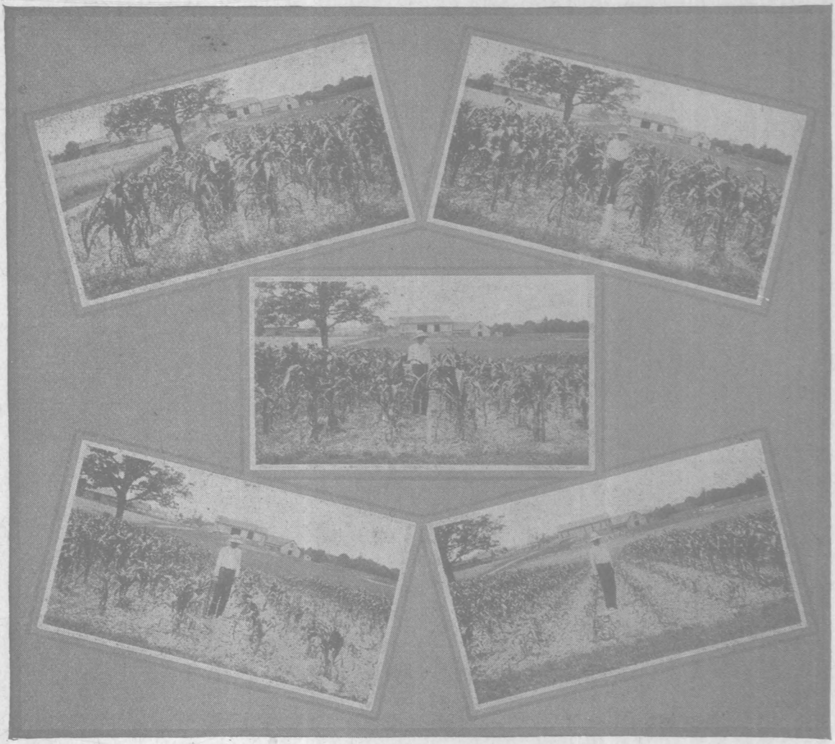
5—EARLY AND LATE PLANTING

The relation of time of planting corn to yield per acre and quality of product is shown by experiments extending over a period of 6 years conducted at Wooster, latitude 40 deg. 41 min., altitude 1,030 feet. It has not been possible to plant corn on a certain day, year after year, owing to conditions of weather. The earliest date of planting (see Table V), has ranged from April 24 to 29. This is from 2 to 3 weeks earlier than the earliest planting would ordinarily be done by the farmers of the community. The greater part of the planting would ordinarily be done from May 20 to 30; more corn being planted after May 30 than before May 15.

TABLE V: Early and late planting

Year	Bushels shelled corn per acre				
	April 24-29	May 4-10	May 14-17	May 25-28	June 2-6
1908	30.16	56.02	61.68	50.66	40.88
1909	100.19	98.94	91.08	81.34	62.88
1910	42.45	37.14	37.27	27.67	20.19
1911	67.04	75.96	73.76	54.83	43.95
1912	65.87	64.12	61.99	49.38	44.95
1913	77.43	78.75	76.64	65.36	53.04
6-yr. average.	63.86	68.49	67.37	54.87	44.32

The largest average yield has been secured from planting May 4 to 10, with larger yields from planting April 25 than May 25. Corn planted the first days of May has given a yield of shelled corn more than 50 percent greater than corn planted the first days of June. Here is evidently an opportunity for adding a few bushels to Ohio's corn yield.



April 29 May 26 — May 16 — May 7 June 6

Fig. 1. Early and late plantings of corn.
Photographs taken July 9, 1914.

In Table VI the moisture determinations of the different plantings are given as made with the Brown-Duval tester at husking time in November.

TABLE VI: Moisture: Early and late planting

Year	Percent of moisture in fall				
	April 24-29	May 4-10	May 14-17	May 25-28	June 2-6
1908	17.0	16.5	18.6	23.9	30.0
1909	26.5	27.4	28.1	29.9	37.8
1910	27.2	28.7	27.3	30.0	33.7
1911	22.8	23.0	25.6	28.6	31.6
1912	25.6	28.8	30.0	33.4	35.4
1913	23.3	26.1	26.0	29.0	32.6
6-yr. average	23.73	25.08	25.93	29.13	33.52

In Table VII are recorded the number of pounds of shelled corn in April from 50 lbs. of ears weighed from each lot in November. On this basis it has required 78.62 lbs. of ears (November weights) of the planting of April 24-29 to equal a bushel of shelled corn the following April, and 91.95 lbs. of ears of the planting of June 2-6.

TABLE VII: Early and late planting

Year	Shelled corn from 50 lbs. ears as weighed in November				
	April 24-29	May 4-10	May 14-17	May 25-28	June 2-6
1908..........	37.50	36.50	36.50	31.75	30.00
1909..........	.....	.....	.....	.....	.....
1910..........	34.50	32.50	33.50	31.75	29.75
1911..........	35.25	34.50	34.25	32.25	31.00
1912..........	34.25	34.00	30.75	30.25	30.00
1913	36.50	35.25	34.50	32.25	31.50
5-yr. average.	35.60	34.55	33.90	31.65	30.45

6—IN HILLS OR DRILLS?

Ohio Station tests conducted by Prof. Hickman in 1894, '95 and '96, comparing the planting of corn in hills and drills, gave the results shown in Table VIII:

The number of plants per acre being the same, there is a gain of 4½ bushels per acre in favor of one plant every 12 inches, as compared with three plants every 36 inches. The gain in stover is 659 lbs. per acre. In deciding whether to plant corn in hills or drills, the cultivation and harvesting of the crop should be considered. Where the weed problem is a serious one the cultivation of drilled corn is more expensive. Corn planted in hills is more easily harvested by hand than in drills, while drilled corn is handled better by the corn harvester.

TABLE VIII: Hill vs. drill planting. Three-year average—Rows 42 inches apart.

No. of plants per hill	Distance apart of hills Inches	No. of plants per acre	Yield per acre	
			Grain—Bus.	Stover—Lbs.
1	12	12,446	46.88	2,827
2	24	12,446	46.28	2,417
3	36	12,446	42.33	2,168
4	48	12,446	42.85	2,180

7—RATE OF PLANTING

Just what constitutes a full stand of plants, is something about which no iron clad rule can be laid down.

In Table IX there is given information with respect to the most desirable number of plants per hill under such conditions as prevail at Wooster where the soil, a silt loam lying upon the Waverly series, receives 10 to 12 tons phosphated manure and 1 ton of finely ground limestone on good clover sod, and where the annual temperature and rainfall (average for 26 years, 1888-1913) are 49.3 degrees and 40.08 inches, respectively. Rates of planting have varied from 1 to 5

TABLE IX: Rate of planting.

Year	No. plants per		Bushels shelled corn per acre	Pound stover per		Average weight of ears	Percent of nubbins
	Hill	Acre		Acre	Bushel of corn		
	1..........	3,555	30.79	1,750	56.8	.635	11.5
	2..........	7,110	48.77	2,500	51.3	.578	21.3
1904	3..........	10,665	60.46	3,610	59.7	.557	21.1
	4..........	14,220	65.40	3,775	57.7	.502	27.1
	5..........	17,775	59.73	4,090	68.5	.431	37.1
	1..........		33.01	2,680	81.2	.701	7.7
	2..........		59.68	3,870	64.9	.676	9.9
1906	3..........	"	73.96	4,350	58.8	.594	15.7
	4..........		78.47	4,580	58.4	.507	25.2
	5..........		78.14	5,500	70.4	.429	42.8
	1..........		28.76	2,848	99.0	.763	10.1
	2..........		41.14	3,791	92.2	.623	19.6
1907	3..........	"	40.09	4,147	103.4	.474	34.3
	4..........		39.09	5,437	113.5	.405	48.0
	5..........		35.91	5,695	158.6	.354	58.5
	1..........		33.32	2,660	79.8	.627	11.8
	2..........		51.47	3,400	66.1	.625	12.5
1908	3..........	"	62.62	3,870	61.8	.549	6.9
	4..........		64.85	4,190	64.6	.459	13.4
	5..........		67.40	4,590	68.1	.395	21.0
	1..........		36.02	3,300	91.6	.740	18.1
	2..........		63.30	4,710	74.4	.786	8.8
1909	3..........	"	81.36	5,670	69.7	.710	11.6
	4..........		91.24	6,300	69.0	.622	12.6
	5..........		98.38	6,990	71.1	.565	20.6
	1..........		17.01	1,200	70.5	.514	19.6
	2..........		29.24	1,930	66.0	.435	31.4
1910	3..........	"	26.48	2,450	92.5	.330	55.2
	4..........		24.38	2,930	120.2	.258	70.4
	5..........		25.24	3,530	139.9	.266	74.2
	1..........		32.58	1,800	55.3	.646	21.7
	2..........		52.36	2,850	54.4	.673	14.5
1911	3..........	"	72.63	3,480	47.9	.663	13.7
	4..........		80.39	3,810	47.4	.550	22.6
	5..........		77.92	4,050	52.0	.466	34.9
	1..........		28.55	2,020	70.8	.631	21.5
	2..........		46.94	3,170	67.5	.697	24.8
1912	3..........	"	64.02	3,880	60.6	.582	20.1
	4..........		57.02	3,800	66.6	.455	30.8
	5..........		51.69	3,500	67.7	.380	47.3
	....		40.26	2,150	53.4	.694	19.1
	2..........		61.12	2,905	47.5	.674	11.0
1913	3..........	"	73.59	3,365	45.7	.634	10.2
	4..........		75.11	3,625	48.3	.461	26.3
	5..........		72.02	4,095	56.9	.404	42.8
	1..........		36.73	2,660	72.4	.661	20.1
	2..........		54.31	3,650	67.2	.646	13.3
1914	3..........	"	64.95	4,380	67.4	.516	30.4
	4..........		73.03	5,160	70.7	.496	34.4
	5..........		63.36	5,770	91.1	.432	46.5
	1..........	3,555	31.70	2,307	72.8	.661	16.1
	2..........	7,110	50.83	3,278	64.5	.641	16.7
10 yr. av.	3..........	10,665	60.77	3,920	64.5	.561	21.9
	4..........	14,220	64.90	4,361	67.2	.471	31.1
	5..........	17,775	62.98	4,781	75.9	.412	42.6

plants per hill in rows 42 inches apart each way. Corn has been planted liberally and later thinnned, thereby insuring an almost perfect stand.

Varying soil and climatic conditions call for a varying number of plants per acre. This fact is nicely brought out by the yield from different rates of planting on several different types of soil reported by the Illinois Experiment Station*; the results of that test showing that for maximum production, the stand of plants should increase with the fertility of the soil.

Consulting the 10-year average results it may be noted that the yields of shelled corn from the various rates of planting, in the order of their rank, are as follows: 4 plants, 5 plants, 3 plants, 2 plants and 1 plant. While the total yield of corn from both the 4 and 5 plant-rates has exceeded that from the 3 plants, yet, in view of the slightly inferior quality of the grain, as indicated by the smaller size of ears and the greater percent of nubbins, the 3 plant-rate may be regarded as most satisfactory, where ears of high class are the chief end in view. But if the crop is to be fed from the shock, then the smaller ears and the finer and greater abundance of forage, as produced by the thicker rates of planting, are the more desirable.

On the more productive soils 36x42 inches would perhaps be a more suitable spacing of hills, thereby giving to each acre a stand of 12,400 plants—a number mid-way between 10,665, and 14,220—the theoretical stands from 3 and 4 plants respectively, in hills 42 inches apart each way.

8—DEEP OR SHALLOW CULTIVATION

Experiments comparing deep and shallow cultivation of corn were conducted by Prof. Hickman for 9 years, beginning in 1891. For the deep cultivation the old-time dôuble shovel was used, working the ground to a depth of four inches. For the shallow cultivation a spring tooth cultivator was used to a depth of one and one-half inch.

With the exception of one season, there was a very decided gain for the shallow cultivation in both grain and stover. The average gain is 4 bushels of grain and 213 pounds of stover.

TABLE X· Deep vs. shallow cultivation. Nine-year average

Cultivation	Implement used	Depth of cultivation Ins.	No of plots	Av yield per acre	
				Grain Bus	Stover Lbs.
Deep.	Double shovel	4	34	56.4	2,691
Shallow	Spring-tooth	1½	31	60.4	2,874

*Ill Exp Sta, Bul No 126.

9—LATE CULTIVATION

How late in the season should corn be cultivated, is a question asked by many farmers. A test was started in 1913 which it is hoped will, in a few years, give some information of value. Two years' work means but little, but it is recorded for what it is worth. Five cultivations were given both the ordinary and the late cultivated plots alike in June and early July. The ordinary cultivation then ceased and the late cultivated plots were given three additional cultivations in July and August, with a one-horse cultivator. The dates of the several cultivations are recorded in Table XI.

TABLE XI: Late cultivation

Year	Date of cultivation								Bus per acre		Gain
	Ordinary					Late					
	June			July		July		Aug.	Ordinary	Late	
1913	5	13	23	2	10	17	26	9	73.74	75 14	1 40
*1914	4	15	25	3	13	18	30	8	46 50	51.98	5.48
2-yr. av	.										3.44

*Ear corn reduced to 15% moisture

In 1913 there were 4 of the late cultivated plots and 3 of the ordinary, arranged alternately. In 1914 there were 4 plots of each. The gain for late cultivation in 1913 is not sufficient to pay the expense of the extra cultivations. The gain in 1914 will more than pay the expense.

It is to be expected that results will vary from year to year, depending upon weather conditions. The rainfall for July, 1913, was 4.07 inches; for July, 1914, 1.23 inches.

10—VARIETY TEST

While a good many varieties of corn have been tested by this Station at different times, only 5 have a complete record for the past 10 years. The varieties recorded in Table XII are quite well adapted to the conditions prevailing in the vicinity of Wooster. The variation in yield, while not large, affords some opportunity for increasing one's yield.

TABLE XII: Variety test

Variety	Bushels shelled corn per acre										
	1905	1906	1907	1908	1909	1910	1911	1912	1913	*1914	10-yr. av.
Clarage.	72 89	62.70	65 32	68 33	85.98	36.58	68 54	67 00	65.00	66.59	65.89
Darke Co. Mammoth	92 37	75.03	62.42	73.12	93 34	31.29	66 56	81 12	58.63	63.71	69.76
Leaming. . . .	94.95	73.18	61 13	73.36	94 52	36.51	74.68	70 28	70.80	69.65	71.91
Medina Pride .. .	80 61	69.55	67 39	74.65	92 89	34.21	68 54	80.32	70 48	69.62	70.83
Strain 84 (Reid) .	88.77	79 94	70 01	72.22	84.13	38.42	75.28	80 49	65 49	66 70	72.14
White Cap.	74.98	.... .	.....	[1]71.47	.	[2]34.95	. .	78.27	64.99	63.89	64.76

[1]Wing's [2]Cranz's *Ear corn reduced to 15% moisture

The necessity for care in using varieties from a distance, and especially in risking any considerable acreage with them, is illustrated in Table XIII. These varieties were all Ohio grown, yet it is quite evident that some of them were carried too far from home. Medina county joins Wayne, and the conditions of growth are much the same.

TABLE XIII: Variation in adaptability. Seven varieties grown in Wayne county, 1913.

Variety	Date of tasseling	Average height of plants Ft.	Ins.	Bushels shelled corn per acre	Percent shrinkage	Stover per acre Lbs.
Connor's Prolific—Clark Co..	8-6	9	8	36.19	37.0	5,200*
Boone County White—Ross Co.	7-29	8	9	56.20	26.5	3,440
Orcutt's Reid—Madison Co..	7-28	9	9	63.37	29.5	4,290
Plessinger's Leaming—Darke Co.	7-27	8	4	61.42	23.0	3,140
Leaming—Wayne Co	7-25	9	2	70.43	23.4	3,652
Medina Pride—Medina Co.	7-23	8	10	70.48	21.5	3,700
Clarage—651—Wayne Co	7-25	8	3	69.96	22.0	3,260

*Not as dry when weighed as the other varieties. Originally from the South Atlantic states.

It should be said that, while Connor's Prolific has been grown one or more seasons in Ohio, it is a typical southern corn and is better adapted to silage use than to grain.

THE RELATION OF PROMINENT EAR CHARACTERS TO YIELD

Five years ago a progress report was made in Bulletin 212 of studies of the relation of certain ear characters to yield, which were then under way. These studies have, for the most part, been continued to the present time, and the results to date are included in this report. Attention should be called to the fact that these contrasted characters have been compared on adjoining plots for the sake of accuracy in determining yields. Accordingly only one parent—the female—has been under control.

11—LONG VS. SHORT EARS

This work was begun in 1905. Four varieties of corn have been used during the test and with three of them the selection has been continuous—long from long, short from short—since 1908. The average difference in length between the long and the short ears used for seed has been 2.44 inches.

Bulletin 212 gave the average results of the first 5 years as showing a gain of 3.97 bushels per acre in favor of the long ears. It was stated that the yields for the last year then reported were ear-corn weights reduced to 15% moisture, in lieu of shelled corn, as for the previous 4 years. The following spring the shelling records were secured and they changed the 5-year average from 3.97 bushels to 3.45.

The record for the full 10 years is given in Table XIV. It will be noted that the long ears lead, on the average, only 1.39 bushel per acre, a difference no greater than might have been expected if the seed used had been identical. It therefore appears that within a variety, at least, the length of an ear of corn is largely a matter of environment, and cannot be expected to influence materially succeeding generations.

TABLE XIV: Long vs. short ears.

Year	Yield per acre				The seed used			
	Bushels shelled corn		Pounds stover		Average length of ears in inches		Average weight of ears in ounces	
	Long	Short	Long	Short	Long	Short	Long	Short
1905..........	97.05	92.85	5,400	4,490	....	....	....	....
1906..........	72.64	65.57	3,400	3,130	....	....	.....	.....
1907...........	62.33	61.95	4,102	4,142	10.45	8.25	12.87	10.80
1908..........	73.32	70.02	3,947	3,888	....	....	.....	.....
1909..........	89.50	87.22	5,652	5,508	9.58	7.38	12.52	10.34
1910...........	30.40	37.31	4,297	3,590	9.50	6.90	12.12	9.45
1911...........	68.74	70.59	4,325	3,885	8.45	6.22	9.35	7.12
1912..........	65.82	62.40	3,889	3,439	8.67	6.42	11.05	8.51
1913.........	70.05	67.23	3,845	3,342	8.97	6.10	10.42	7.31
*1914.......	65.65	66.43	4,150	3,880	8.87	6.13	10.80	7.76
10-yr. average.	69.55	68.16	4,301	3,929	9.21	6.77	11.30	8.76

*Ear corn reduced to 15% moisture.

Careful measurements of the entire crop harvested have been made with one variety—the Clarage. These data are given in Table XV.

TABLE XV: Long vs. short ears—Clarage.

Year	Yield per acre				Length of ears in inches in:					
	Bushels shelled corn		Pounds stover		Seed used			Crop harvested		
	Long	Short	Long	Short	Long	Short	Difference	Long	Short	Difference
1907.....	64.95	65.38	3,900	3,960	9.43	7.11	2.32	7.56	7.12	0.44
1908...	68.22	67.77	3,775	3,835	....	...	....	...	....	....
1909.....	85.49	82.58	5,280	5,340	8.90	6.60	2.30	7.92	6.87	1.05
1910.....	31.03	36.74	3,820	3,360	9.50	6.90	2.60	6.25	5.58	0.67
1911.	64.81	69.28	4,140	3,570	8.50	6.20	2.30	6.85	6.51	0.34
1912....	62.13	55.90	3,722	3,311	8.90	6.60	2.30	7.20	6.28	0.92
1913....	68.96	63.61	3,785	3,285	8.90	6.30	2.60	7.58	6.29	1.29
*1914..	61.68	62.29	4,070	3,740	9.10	6.10	3.00	....	....	....
8-yr. av..	63.41	62.94	4,062	3,800	9.03	6.54	2.49	7.23	6.44	.78

*Ear corn reduced to 15% moisture.

12—CYLINDRICAL VS. TAPERING EARS

Whether the cylindrical ear or the tapering ear is the more desirable for seed purposes is a question about which there has been much diversity of opinion among corn growers; some contending for the cylindrical, some for the tapering.

To obtain information along this line, cylindrical and tapering ears have been compared with each other on the Station farm for the past nine seasons (1906-1914 inclusive). Throughout this time there have been used two varieties—the Darke Co. Mammoth and Leaming—the cylindrical ear being a marked characteristic of the former and the tapering ear of the latter variety. Four years out of the nine there was included also a third variety—Reid—a variety in which neither of the characters in question is pronounced, its shape being midway between that of the other two.

Within each variety cylindrical and tapering ears have been sorted out for seed; the two classes differing from each other as much as was consistent with the use of ears usually regarded as suitable for seed. Data with reference to circumference, length and weight of ears of all varieties used are given in Table XVI. With two varieties the selection of seed has been continuous; cylindrical from cylindrical, tapering from tapering.

TABLE XVI: Cylindrical vs. tapering ears

Year	Yield per acre				Circumference of seed ears				Av. length in inches		Av. weight in ounces	
	Bus. shelled corn		Lbs. stover		Cyl.		Tapr.					
	Cyl.	Tapr.	Cyl.	Tapr.	Butt	Tip	Butt	Tip	Cyl.	Tapr.	Cyl.	Tapr.
1906	71.73	76.47	3,532	3,637	....	....	....	....	....	....	....	.....
1907	61.35	60.98	4,137	4,270	....	....	....	....	....	....	....	.....
1908	72.88	73.10	3,977	3,950	....	....	....	....	....	...	....	....
1909	90.79	89.92	5,635	5,475	7.35	6.52	7.15	5.67	8.20	8.85	12.50	11.57
1910	28.91	30.98	4,593	4,510	7.55	6.70	7.25	5.75	8.30	8.77	11.90	11.47
1911	67.78	64.09	4,327	4,423	7.00	6.33	6.50	5.63	7.63	7.73	9.83	8.23
1912	71.91	78.20	4,145	4,200	7.20	6.60	6.80	5.75	7.80	8.25	10.22	10.08
1913	66.30	71.75	3,845	4 035	7.15	6.35	6.95	5.40	8.05	8.55	10.20	9.48
*1914	68.08	69.13	4,025	4,295	7.05	6.45	6.70	5.65	7.80	8.25	10.81	9.85
9 yr. av.	66.64	68.29	42.46	43.11	7.22	6.49	6.89	5.64	7.96	8.40	10.91	10.11

*Ear corn reduced to 15% moisture

As an average of the 9 years' tests the tapering ears have been found to be 1.65 bushels per acre in the lead. In view of this small increase, and of the further fact that 3 years of the 9 the cylindrical ears led in yield, it would seem that neither character is to be taken as an index to superiority in the production of shelled corn.

13—BARE VS. FILLED-TIPPED EARS

In 1907 a test was started to determine the effect of the continued use of ears having more or less bare cob at the tip end. The variety of corn used is the Clarage. Ears having ¾ to 1½ inch of bare cob have been compared with ears completely filled out at the tip. Throughout the test the selection of seed has been continuous, that is, bare-tipped from bare-tipped and filled-tipped from filled-tipped.

The 8 years' results are given in Table XVII and show, in so far as yield of shelled corn is concerned, as close agreement as one could expect from duplicate plots. The yield from bare-tipped ears averages 62.42 bushels per acre and from filled-tipped ears 62.76 bushels, a difference of 0.34 bushel. The yields of stover have been equally close.

TABLE XVII: Bare vs. filled-tipped ears.

Year	Yield per acre				Average length of bare cob in inches in:				
	Bushels shelled corn		Pounds stover		Seed used		Crop harvested		
	Bare	Filled	Bare	Filled	Bare	Filled	Bare	Filled	Difference
1907.....	58.21	58.34	3,510	3,220	....	....	.....	....	....
1908....	64.07	65.52	3,850	3,770	....	....	.....	....	....
1909.....	78.83	80.54	5,260	5,340	....	....	1.030	.530	.500
1910....	34.50	34.96	3,530	3,470	1.29	00	.572	.288	.284
1911.....	72.55	69.41	3,740	3,780	1.30	00	.744	.329	.415
1912....	58.31	63.61	3,600	3,400	1.37	00	.785	.389	.396
1913.....	68.60	68.52	3,450	3,535	0.87	00	.689	.299	.390
*1914....	64.30	61.18	3,470	3,770	....	....	...	....	....
8-yr. av..	62.42	62.76	3,801	3,786	1.21	....	.764	.367	.397

*Ear corn reduced to 15% moisture.

For 5 of the 8 years the total length of bare cob at the tip of each ear in the crop grown from the two strains has been determined. These measurements have been taken in the spring after the ears were well dried out. The average length of bare cob is recorded for each year and for the 5 years. There has been no marked tendency for the amount of bare cob to increase. As a matter of fact, this sort of selection, though continuous, has been barren of any important results.

14—ROUGH VS. SMOOTH-DENTED EARS

Among corn growers the opinion is quite common that the smoother types of ears are less desirable for seed than are the rougher ones; that lack of marked roughness is an indication of a shortening of the kernels, reduced yield and deterioration in general.

To secure information regarding this interesting point a comparison of rough and smooth ears was started in 1908. For each class there was selected the roughest and smoothest available from among those ears which would pass as suitable for seed. The work has been confined to the use of one variety—the Clarage—and the selection of seed has been continuous, that is, rough from rough and smooth from smooth.

As may be noted from Table XVIII there has been little difference in seed ears with respect to weight and length, and in percent of grain, less perhaps than one might expect, the difference there being only 1.7 percent.

TABLE XVIII: Rough vs. smooth dented ears

Year	Yield per acre				Average of seed ears used					
	Bus. shelled corn		Lbs. stover		Wt. in ounces		Percent grain		Length	
	Rough	Smooth	Rough	Smooth	Rough	Smooth	Rough	Smooth	Rough	Smooth
1908	65.85	64.88	3,635	3,525	....	....	....	....	...	...
1909	84.44	86.71	4,900	5,300	10.8	9.6	84.2	80.7	8.3	8.1
1910	36.27	34.39	3,520	3,860	10.5	10.4	85.8	84.7	8.4	9.4
1911	72.20	72.54	3,840	3,870	8.5	7.3	85.9	83.7	7.4	7.0
1912	59.36	68.90	3,667	3,756	9.6	10.2	86.7	84.4	7.8	7.9
1913	68.47	65.85	3,585	3,585	8.5	9.0	83.5	83.3	7.7	7.9
*1914	58.33	63.97	3,820	3,790	9.9	10.5	84.6	83.9	8.4	7.9
7 yr. av.	63.56	65.32	3,852	3,955	9.6	9.5	85.1	83.4	8.0	8.0

*Ear corn reduced to 15% moisture.

Averaging the results for the entire period—seven years—it is found that the yield of shelled corn from the smooth ears exceeds that from the rough by 1.76 bushel. From the foregoing, therefore, it would seem that if ears are in all other particulars suitable for seed purposes, smoothness of type should not be regarded as sufficient ground upon which to discard them.

15--HIGH VS. LOW PERCENT OF GRAIN

Tests have been conducted during the past 6 years with seed ears varying quite widely in their percent of grain. In beginning this test 200 ears of Clarage seed corn were shelled separately and the percent of grain determined for each year. The 10 ears having the highest percent of grain were thrown together as the foundation of the high-percent strain, and the 10 having the lowest percent of grain, of the low-percent strain. In continuing the test 100 ears have been selected each year from each strain, and the 10 highest from the high-percent strain, and the lowest from the low, used for seed the following year. Since the first year the entire product of each plot has been saved and the spring weight of ears and shelled corn determined. Table XIX gives the data collected to date.

TABLE XIX: High vs. low percent grain

Year	Yield per acre				Percent of grain in			
	Bus. shelled corn		Lbs. stover		Seed used		Crop harvested	
	High	Low	High	Low	High	Low	High	Low
1909	89.83	84.93	5,360	5,700	87.20	79.00	....	....
1910	40.05	41.70	3,380	4,150	87.80	77.10	84.73	83.67
1911	71.42	73.01	3,550	4,170	88.38	76.06	87.30	84.66
1912	57.59	65.81	2,489	4,444	89.53	74.81	85.34	77.86
1913	72.89	61.10	3,185	3,925	88.99	73.34	87.09	76.93
*1914	56.06	63.80	2,920	3,900	87.08	77.95	.....	.....
6-yr. average	64.64	65.06	3,481	4,382	88.16	76.38	86.11	80.78

*Ear corn reduced to 15% moisture.

The difference in yield is 0.42 bushel, in favor of the low-percent strain. The average variation in the percent of grain of the seed used has been 11.78 percent; of the crop harvested, 5.33 percent. While this character is apparently heritable, it has not affected the yield per acre to any great extent in 6 years' time.

16—SEED FROM DIFFERENT PARTS OF THE EAR

For 9 consecutive years experiments were conducted by J. F. Hickman of this Station in the use of seed from different parts of an ear of corn, viz., the butt, middle and tip. After the first year butt kernels were selected from ears that grew from butts, and in like manner middles from middles and tips from tips, continuing for the 9 years.

The results of this test are given in Table XX.

TABLE XX: Seed from different parts of the ear. Average of 9 years' work.

Seed from	Yield per acre		Percent		
	Grain Bus.	Stover Lbs.	Barrenness	Full-sized ears	Nubbins
Butts	58.86	2,848	10.3	66	34
Middles	59.27	2,925	10.4	64	36
Tips	58.70	2,974	10.6	65	35

No variation in time of maturity, or other important characters is reported. Yields of grain and stover, and percents of barrenness, of full-sized ears and nubbins are practically the same. Apparently one part of the ear is as valuable as another for use as seed. The fact remains, however, that in the use of the corn planter it becomes necessary to have the kernels of uniform size. This would seem to be the only reason for separating butt and tip kernels from those in the middle portion of the ear.

17—THE RELATION OF NUMBER OF ROWS PER EAR TO YIELD AND CHARACTER OF PROGENY

In studying the relation of different ear-characters to yield, work was begun with 14, 16 and 18-rowed Clarage corn in 1910. Five consecutive crops have been grown, and after the first year the selection has been continuous. Seed from the same lot used at Wooster has been used at the Germantown test farm each year, and for 3 years at the Carpenter test farm. The yields are given in Table XXI.

TABLE XXI: 14-16-18-rowed Clarage.

Year	Bushels corn per acre								
	Wooster (shelled corn)			Germantown (ear corn)			Carpenter (ear corn)		
	14	16	18	14	16	18	14	16	18
1910	40.93	41.45	40.07	60.39	62.48	62.20	43.41	70.48	69.77
1911	73.44	73.63	71.25	61.34	56.25	50.64	31.16	30.16	24.31
1912... ...	61.97	60.37	61.63	53.10	49.56	47.65	64.00	60.19	55.82
1913... ...	68.83	66.25	69.42	53.75	53.61	54.71	...	.....	...
*1914......	59.13	56.03	57.39	59.22	57.79	55.91	.....	.	...
5-yr. av...	60.86	59.55	59.95	57.56	55.94	54.22	46.19	53.61	49.97

*Ear corn reduced to 15% moisture.

This seed being Wooster grown, originally, as well as during the test, has doubtless been better adapted to Wooster conditions and the results secured at Wooster are probably the more reliable. As with the other ear characters the yield is but slightly affected by this sort of selection, the 5-year average difference at Wooster being but 1.31 bushel, in favor of the 14-rowed strain. At Germantown the 14-rowed strain also excels, though at Carpenter it is poorest.

Counts have been made of the number of rows per ear of each ear grown for 4 crops. These results are given in Tables XXII and XXIII.

The percentage of 14-rowed ears is highest in both the 14-rowed and 16-rowed strains, not only in 1910, but also in 1913. Evidently the tendency of this variety (Clarage) is to produce more 14-rowed ears than of any other type. The percentage of 16-rowed ears is highest in the 18-rowed strain, both in 1910 and 1913. The greatest change resulting from this selection occurs in the 18-rowed strain. In 1910, 24.2% of the crop were made up of 14-rowed ears and only

16.7% were 18-rowed. In 1913, 21.8% were 14-rowed, while 26.6% were 18-rowed. In each of the strains it is to be noted that there has been a tendency to centralize.

TABLE XXII: Crop grown from 14-16-18-rowed Clarage.

Year	No. rows in seed used	Number of ears in crop harvested having rows as follows: 6	8	10	12	14	16	18	20	22	24	26	Total No. ears harvested
1910	14	2	18	50	165	276	212	73	6	1	..	.	803
	16	10	25	43	146	243	241	84	20	1	..	.	813
	18	13	19	41	107	209	282	144	40	8	.	..	863
1911	14	1	10	24	192	493	236	52	10	.	..	..	1,018
	16	2	5	21	96	336	318	128	15	2	.	.	923
	18	.	..	3	66	236	312	146	63	6	5	..	837
1912	14	..	9	21	197	356	184	48	4	2	..	..	821
	16	..	8	21	93	227	247	69	27	7		..	699
	18		4	14	66	194	210	192	42	13	1	1	737
1913	14		..	3	136	356	288	95	20	1		..	899
	16	..	.	3	73	302	295	150	23	8		.	854
	18	..	1	1	44	196	308	239	88	19	4	..	900

TABLE XXIII: The changes in progeny from 1910 to 1913.

Seed strain	Percent of product: 14-rowed 1910	14-rowed 1913	16-rowed 1910	16-rowed 1913	18-rowed 1910	18-rowed 1913
14-rowed.....	34.4	39.6	26 4	32.0	9 1	10.6
16-rowed..	29.9	35.4	29.6	34.5	10.3	17.6
18-rowed..	24.2	21.8	32.7	34.2	16.7	26.6

The three strains have been planted side by side for the sake of accurate comparison of yield, with no effort to prevent cross-fertilization.

18—SELECTING CORN FOR HIGH AND LOW EARS

In 1908 some field selections were made of ears growing high, and others low on the stalk. A number of these ears were planted in ear-row tests in 1909. Fig. 2 shows the variation in the height of ears of some of these rows. Composite samples of high and low eared seed of the same variety were selected from these rows for planting tenth-acre plots in 1910. Fig. 3 shows the general appearance of these plots as harvested in 1910—a year of very low yields, all around, on account of severe July and August drouth.

Fig. 2. Ear-row test, 1909—High and low ears.
Foundation stock.

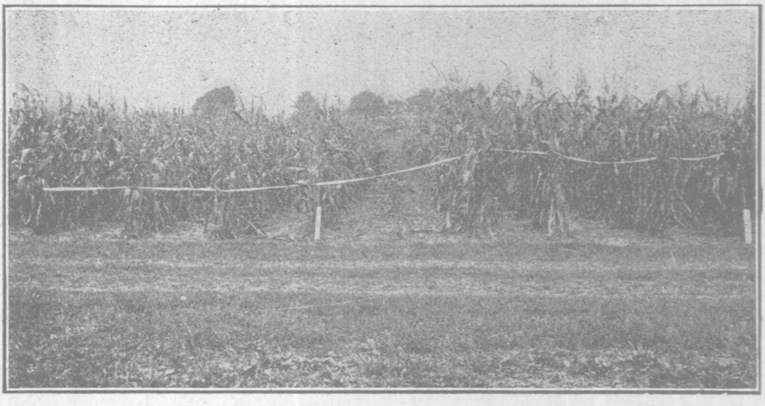


Fig. 3. High and low eared plots, 1910.

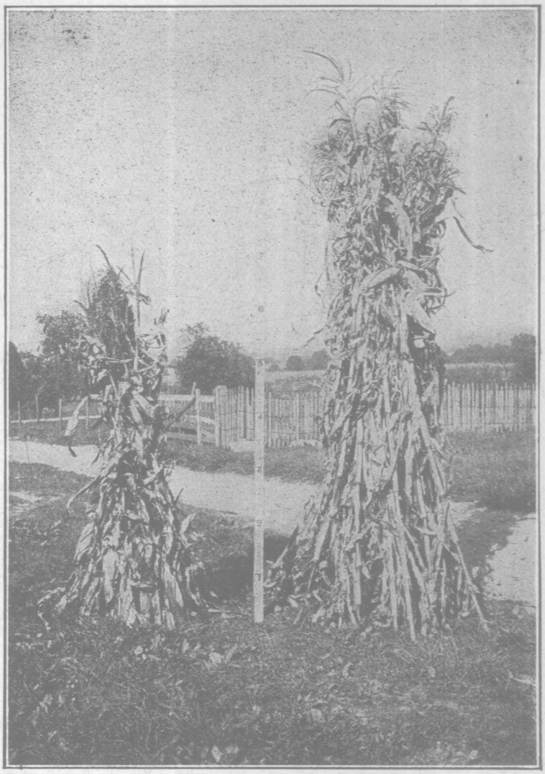


Fig. 4. High and low eared strains. Variation in plants selected for seed.

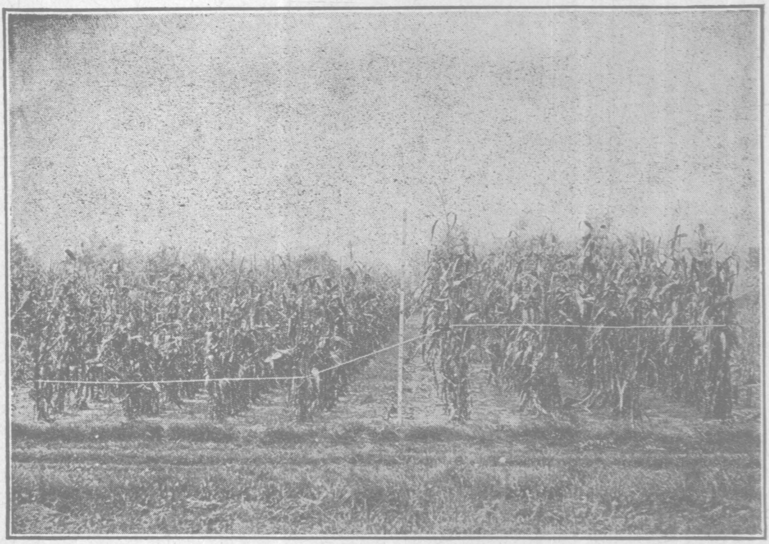


Fig. 5. High and low eared plots, 1913, grown from seed shown in Fig. 4.

For the last 5 years these plots of high and low borne ears have been continued, the highest borne ears being selected each year from the high-eared plot and the lowest from the low for seed the following year. No ears have been chosen, however, unless of good size. There has been no attempt to control crossing, but nature has taken care of this very well, as the low-eared plants are naturally somewhat earlier. Fig. 4 shows the character of the plants selected for seed the last few years. It will be noted that some of the high borne ears are between 6 and 7 feet high, while the low borne are but little more than 1 foot high. Fig. 5 shows the tenth-acre plots of corn grown the following year from this particular seed. Fig. 6 shows the extreme in individual plants growing in adjoining rows.

Fig. 6. High and low ears. Extremes found in adjoining rows.

In Table XXIV are recorded the data gathered the past 5 years with respect to date of tasseling and silking, height of plants and ears, and yield of grain and stover. Each season one-half of all the plants grown of both strains have been measured for height of plants and ears—every plant in every other row. It will be noted that the difference in height of ears has increased each year. The point in mind in making these selections has been the height of ears, but it is evident that earliness has gone hand in hand with low ears.

The matter of yield is, of course, of prime importance. Four of the 5 years the low-eared strain has led in yield of grain, though very much behind in yield of stover. It seems evident from this work that it is possible by continuous selection to develop a variety of corn with lower borne ears and earlier, and yet secure as much grain as with a strain bearing more than 50 percent more stover. The early, light-stover strain excels in yield of grain particularly in seasons of low rainfall. The one year in which the high-eared strain excelled in grain was in 1912, when there was a rainfall at the Station farm of 7.46 inches in July and 7.32 inches in August.

TABLE XXIV: Selecting corn for high and low ears

Year	Position of ear	Tasseling		Silking		On crop grown Height of				Difference in height of ears		Yield per acre	
		Date of	Difference	Date of	Difference	Ears ft	Ears in	Plant ft	Plant in	ft.	in	Bus of shelled corn	Lbs. of stover
1910	High	Aug. 3	3	Aug 7	3	4	2	8	6	1	2	33 21	4,330
	Low	July 31		Aug 4		3	0	7	3			45 44	2,740
1911	High	July 14	8	July 20	9	5	1	9	8	1	8	62 43	4,230
	Low	July 6		July 11		3	5	8	2			67 23	3,370
1912	High	Aug 2	10	Aug 8	11	4	4	8	11	2	2	69 77	4,489
	Low	July 23		Aug 28		2	2	6	8			53 02	2,289
1913	High	July 27	9	Aug 1	9	4	6	9	10	2	2	64 75	3,880
	Low	July 18		July 23		2	4	7	8			66 23	2,730
1914	High	July 21	8	July 28	10	5	4 6	10	2 5	2	7	*55 87	5,240
	Low	July 13		July 18		2	9 5	8	0			*63 89	3,200
	Five-year average									High		57 21	4,434
										Low		59 16	2,866

*Ear corn reduced to 15% moisture

It is easily possible to overdo the matter of selection for low ears. This test has been conducted with the view of determining what could be done by means of selection, rather than what should be done.

19—THE EFFECT OF PREVIOUS CONDITIONS OF GROWTH UPON SEED CORN

A question of great importance to the corn grower is the effect of previous conditions of growth upon the value of seed corn. Will seed grown on rich land, or where the stand of plants is abnormally thin, be any more, or any less productive, as a result of the extra size and quality incident to the conditions under which it is grown?

In 1907 this Station began to grow side by side, under uniformly good conditions, plots of corn planted with two sorts of seed, though both of the same variety and originally identical. The one sort known as the "rich" strain, was being grown year after year on the best manured plot of the Station's fertility work; the other, the "poverty" strain, on an adjoining unfertilized plot. The results of 6 years' tests of these rich and poverty strains are given in Table XXV. They vary in yield 0.06 bushel per acre.

TABLE XXV: Rich vs. poverty strains.

Year	Yield per acre			
	Bushels shelled corn		Pounds stover	
	Rich	Poverty	Rich	Poverty
1907	59.60	60.59	4,400	3,700
1908	68.14	65.82	3,360	3,580
1909	78.52	81.27	4,960	4,900
1910	30.48	33.39	3,860	4,030
1911	67.16	67.19	3,790	3,510
1912	69.64	64.92	3,778	3,689
6-yr. average	62.26	62.20	4,026	3,902

In a somewhat similar test the effect of thickness of planting on the value of the seed produced has been studied for 6 years. The seed used in this test has been selected annually from the Station's "thick and thin" planted plots. The best 25 seed ears obtainable have been selected from the plots having 1, 3 and 5 plants per hill and planted the following year under uniform conditions as the one, three and five plant strains. In the latter part of Table XXVI it will be noted that the average weight of the ears selected for the one plant strain is 11.2 ounces; of the three plant strain 9.6 ounces and of the five plant strain 8.0 ounces. The table further shows that although the average weight of the seed ears used in the one plant strain exceeds the five plant strain by 40 percent, the latter slightly out-yield the one plant strain.

TABLE XXVI: One, three and five plant strains.

Year	Yield per acre						Average of seed ears used					
	Bushels shelled corn			Pounds stover			Weight in ounces			Length in inches		
	One	Three	Five	One	Three	Five	One	Three	Five	One	Three	Five
1909	90.66	88.85	89.01	5,370	5,440	5,300	12.0	10.0	8.0	9.4	8.8	7.9
1910	37.02	37.17	36.74	3,935	3,825	3,835	11.5	10.4	9.5	8.7	8.0	7.8
1911	71.37	69.25	67.12	3,265	3,190	3,120	8.3	6.7	5.8	7.3	6.5	6.2
1912	57.91	67.44	63.32	3,444	3,889	3,600	12.0	11.2	8.3	9.0	8.4	7.4
1913	69.48	65.56	69.60	3,275	3,500	3,465	11.4	9.4	8.2	8.4	7.9	7.5
*1914	57.00	58.43	59.83	3,580	3,720	3,760	12.1	9.9	8.4	8.6	7.9	7.2
6-yr. av.	63.91	64.45	64.27	3,811	3 927	3,847	11.2	9.6	8.0	8.6	7.9	7.3

*Ear corn reduced to 15% moisture.

In the light of these tests it must be concluded that the conditions of growth are not important factors in the selection of seed corn.

20—CONDITIONS AFFECTING BARRENNESS

That so-called barren plants are responsible for an appreciable loss in the yield of corn from year to year, is very generally conceded. There are a number of conditions affecting barrenness, among them, differences that may be described as seasonal. This fact is brought out in Table XXVII which gives the percent of barren plants found four different seasons on certain plots in the 5-year rotation fertility work. It matters not whether the plots receiving liberal amounts of fertilizer be considered, or the unfertilized plots, it will be noted that there are marked differences in the amount of barrenness in different seasons. There is, for instance, four times as much barrenness in the year 1897 as in the year 1902, on both the fertilized and the unfertilized plots. Comparing the year 1908 and 1910, there is more than 20 times the amount of barrenness on the fertilized plots in 1910 that there is in 1908, and more than 12 times as much on the unfertilized plots. Each of the plots figuring in these data was treated the same each of the 4 years. The differences noted are therefore purely a matter of variation in seasons.

TABLE XXVII: Percent of barren plants as affected by fertility and season

Plot	Fertilized				Plot	Unfertilized			
	1897	1902	1908	1910		1897	1902	1908	1910
11	7.4	1.2	1.3	35.2	1	25.9	8.0	9.8	54.2
12	11.2	1.6	2 0	32.4	4	11.1	3.6	3.6	49.9
14	13.3	2.6	1.0	39.6	7	10.5	4.6	3.4	44.9
17	10.7	2 8	0 7	25.0	10	15.1	5.6	4.2	46 5
18	8.0	2.8	0.5	17.0	13	12.5	4.5	3.2	56.9
20	3.9	1.5	0.9	29.8	16	35.0	4.8	5.2	69.9
21	9.3	2.5	1.3	24.8	19	21.6	3.0	3.5	51.4
23	13.5	2.3	1.1	26.4	22	23.5	4.2	3.7	58.3
24	8.3	3.1	0.7	24.5	25	13.6	2.5	2.7	45.7
26	7.2	1.5	1.8	41.6	28	8.0	2.9	1.5	45.3
27	6.5	1.2	3.0	30.1	..	....	..	...	....
29	7.5	1.4	1.0	31.8	..	....	...	...	...
30	6.4	3.8	1.3	20.7	..	....	...	...	....
Average..	8.70	2.17	1.27	29.15		17.68	4.37	4.08	52.30

It is also apparent from this table that the fertility conditions affect barrenness. Comparing the fertilized plots with the unfertilized for the year 1897, there are twice as many barren plants on the unfertilized plots as on the fertilized. The same is true in 1902 and 1908, when the amount of barrenness is unusually low on both sets of plots. In 1910, when the amount of barrenness is abnormally high, there is nearly the same ratio between the fertilized and unfertilized plots.

A consideration of the time of planting reveals the fact that it also sustains a definite relation to the amount of barrenness. In the early and late planting test—see Table XXVIII—the same variety has been used throughout; fertility, rate of planting and all other conditions, except date of planting, have been as nearly alike as it has been possible to make them. Averaging the percent of barrenness for each date of planting for the 6 years, there is a very gradual increase for the first 3 dates, then a sharp increase for the last 2 dates. The amount of barrenness for the latest planting is 2.7 times greater than for the earliest.

As might be expected, the stand of plants also affects the amount of barrenness. In the test reported in Table XXVIII the hills of corn were 42 inches apart each way. The amount of seed planted was greatly in excess, so that it was possible to thin to the desired stand. As noted, there has been little difference in amount of barrenness with 1 and 2 plants per hill. Such stands are below normal and there is opportunity for the natural development of the plant. With 3 plants per hill there is more barrenness, and with 4 and 5 the increase is marked, being 5 times as great with 5 plants per hill as with 1 and 2 plants.

TABLE XXVIII: Percent of barren plants as affected by time of planting and stand of plants

Year	Early and late					Number of plants per hill				
	April 24-29	May 4-10	May 14 17	May 25-28	June 2-6	1	2	3	4	5
1904	.	..	...	..		1.7	1 7	3.9	5.1	10 3
1906	..	..		...	....	2.6	2.3	2.9	5.7	9.6
1907	....	..	....	...		1.9	3.1	7.3	13.7	19.7
1908	..	.	...		..	2 6	2.0	1.1	2 9	2.8
1909	4.1	6.2	8 2	12 1	12 5	1.4	0.8	1.8	5.3	6.9
1910	11.6	11.7	13 9	24.4	36.0	1.9	2.7	13.1	24.1	33.9
1911	1.2	3.3	2.4	5.5	9 6	1.4	1.6	1.9	2.7	4.6
1912	2 3	2.9	2 8	3 2	1 8	1.1	1.7	2.9	5.1	9.0
1913	2.5	1.0	2.3	2 8	5.0	3.1	1.8	2.4	5.6	5.2
1914	3.7	4.2	2.3	2.1	4.6	2.7	2.5	3.4	10.0	14.9
Average	4.23	4.88	5.32	8 35	11.58	2.04	2 02	4.1	8.0	11.7

In gathering data in regard to barrenness in individual ears of corn tested in ear-row work, while it has been found that there is some variation with respect to this character, it has hardly been possible to distinguish between barrenness due to heredity (if such exist) and that due to lateness in maturity. In most instances an excess of barrenness has been accompanied by lateness in maturity, which in itself, as has been shown, favors barrenness.

From the foregoing data it will be seen that a very considerable part of the barren plants found in our corn fields may be accounted for on the ground of conditions of growth.

21—THE EAR-ROW TEST

For the past ten years an annual ear-row test nas been conducted, followed each year by an isolated breeding plot in which the highest yielding ears of the previous ear-row test have been crossed, using portions of the original ears rather than their progeny. The method followed provides for as careful selection of the sire as of the dam, both being tested in advance of their use in the breeding plot. For a detailed description of the method followed, see Circular 66, of this Station.

The pedigreed strains reported in Table XXIX date back to ears tested in 1905. The best ears of 1905 were crossed in 1906 and three pedigreed strains secured (Nos. 41, 42 and 43), which were tested in the annual variety plot tests of 1907 and 1908, with results as recorded under group 1 of Table XXIX. Selected ears from these strains, as well as ears of the same variety from the general field, were also tested in ear-row tests of 1907 and the best of them crossed in 1908. This second group of pedigreed strains was tested in the variety plot tests of 1909, '10 and '11, as indicated under group 2. The work has been followed up in a similar way to date. Six different groups, consisting of 20 pedigreed strains, are herewith reported.

TABLE XXIX: Yields of pedigreed strains of corn.

Group	Strain (O. P. B. A. No.)	Years tested	Av. yield for years tested	Av. yield of checks for years tested	Av. + or — over check
1	41	1907-08	77.45	79.43	—1.98
	42	1907-08	84.41	79.43	+4.98
	43	1907-08	83.68	79.43	+4.25
2	95	1909-10-11	80.67	74.43	+6.24
	96	1909-10-11	82.67	74.43	+8.24
	97	1909-10-11	81.74	74.43	+7.31
3	202	1910-11	64.72	61.04	+3.68
	203	1910-11	66.24	61.04	+5 12
	204	1910-11	62.51	61.04	+1.47
	205	1910-11	69.57	61.04	+8.53
4	315	1911-12	88.62	80 44	+8.18
	316	1911-12	82.21	80.44	+1.77
	317	1911-12	83.03	80.44	+2.59
5	651	1913	84.16	79.03	+5.13
	652	1913	82.60	79.03	+3.57
	653	1913	78.91	79 03	—0.12
6	803	1914	79.84	73.60	+6 24
	804	1914	77.37	73.60	+3.77
	805	1914	84.60	73.60	+11.00
	806	1914	81.22	73.60	+7.62

These 20 strains have been tested in the regular variety test plots in which every fourth plot has been a "check," planted with the original variety (Clarage) from which the pedigreed strains have been developed. The yield of the latter is given in column 4, and of the check in column 5. In the last column is recorded the gain or loss in yield of the pedigreed strains. In only two instances has there been a loss.

The results as a whole seem to indicate that about all that can be expected from this method of corn breeding is an increase of 5 to 10 bushels per acre.

In the many ear-row tests which have been conducted some interesting variations in character of plants have been observed; among them variations in stiffness of stalk. Fig. 7 shows a row of corn from ear 11,027 which proved to be very weak in stalk, going down badly just before harvest. Fig. 8 shows a nearby row from ear 11,048 illustrating the other extreme—a very stiff stalk. There were 105 plants in each row. In one instance 80 plants went down; in the other, only 2.

Table XXX gives the data regarding the two rows.

TABLE XXX Variation in stiffness of stalk

Character of plant	No. of row	Av height of		No of plants		Percent plants down	Yield per acre	
		Plants ft ins	Ears ft ins	Harvested	Down		Grain Bus	Stover Lbs
Upright	11,048-B	8 6	3 9	105	2	1 9	114 55	5 867
Down .	11,027 B	8 7	3 2	105	80	76 2	88 12	5,690

This character of stiffness of stalk is not explained by the comparative height of plants or ears, nor by the load of grain carried. It is apparently something inherent in the plant itself.

22—CROSS BREEDING CORN

The effect of cross breeding varieties and pedigreed strains of corn upon yield has been tested three seasons. Table XXXI gives the results of tests comparing 17 first generation crosses with their parent varieties. It should be stated that the seed used of the parent varieties was one year older than that of the crosses, which according to results secured by Hartley (Bulletin 218, Bureau of Plant Industry) might give a slight advantage to the crosses.

In the year 1912, 7 crosses were tested. Three of these crosses are intermediate in yield between the parent varieties; two are poorer than either parent and two are better than either parent. Of the latter, only one cross is more than two bushels higher in yield than the better parent, and only such crosses can probably be regarded as of any particular advantage.

Fig. 7. Variation in ear-rows.
Weak stalks.

Fig. 8. Variation in ear-rows.
Stiff stalks.

In 1913, 6 crosses were tested. Only two of these had both parents growing beside them and neither cross, by the rule just stated, can be regarded as advantageous. Four crosses are compared with the male parent and all four are superior. Two reciprocal crosses were made. They vary less than one bushel per acre in yield of grain, only 40 pounds per acre in yield of stover and show the same percentage of moisture.

TABLE XXXI: **First generation crosses, 1912-'13-'14.**

Variety and cross	Yield per acre		Increase or decrease over:		Percent moisture in ear-corn in November
	Bushels shelled corn	Pounds stover	Male parent	Female parent	
1912					
Leaming	70.28	3,689	....	....	27.9
Leaming × Darke Co. Mammoth	75.45	4,133	−5.67	+5.17	29.7
Darke Co. Mammoth	81.12	4,556	....	....	31.4
Reid	67.39	3,922	....	....	31.2
Reid × Darke Co. Mammoth	84.15	4,556	+3.03	+6.76	32.5
White Cap (McGinnis)	65.89	3,400	....	....	31.4
White Cap (McGinnis) × Darke Co. Mam.	72.69	4,356	−8.43	+6.80	33.2
Sel. 207 (Reid)	55.33	3,600	....	....	....
Sel. 207 (Reid) × Sel. 205	59.99	3,756	+0.11	+4.66	....
Sel. 205	59.88	3,400	....	....	....
Sel. 315	72.44	3,956	....	....	....
Sel. 315 × Sel. 205	68.08	3,378	+8.20	−4.36	....
Sel. 316	60.86	3,489	....	....	....
Sel. 316 × Sel. 205	55.77	3,133	−4.11	−5.09	....
Sel. 317	63.11	3.222	....	....	....
Sel. 317 × Sel. 205	59.45	3,089	−0.43	−3.66	....
1913					
Medina Pride	70.48	3,700	....	....	28.70
Medina Pride × Leaming (Frost)	70.69	3,640	+5.20	+0.21	27.60
Leaming (Frost) × Medina Pride	71.47	3,600	+0.99	+5.98	27.60
Leaming (Frost)	65.49	3,390	....	....	28.00
Sel. 205 × Leaming (Frost)	73.16	3,575	+7.67	....	27.20
Sel. 205 × Medina Pride	73.89	3,280	+3.41	....	27.30
Sel. 207 × Leaming (Frost)	74.69	3,515	+9.20	....	28.60
Sel. 207 × Medina Pride	76.03	3,760	+5.55	....	25.20
1914*					
Medina Pride	69.62	3,860			23.55
Medina Pride × Darke Co. Mammoth	71.17	4.550	+7.47	+1.55	25.65
Darke Co. Mammoth	63.70	4,670	....	....	29.00
Leaming (Frost)	71.44	4,100			
Leaming (Frost) × Darke Co. Mam	71.10	4,400	+7.40	−0.34	24.35
Stauffer's Yellow	60.75	3,980			22.75
Stauffer's Yellow × Darke Co. Mam	63.82	4,200	+0.12	+3.07	26.50
White Cap (Snure)	63.89	3,430			20.40
White Cap (Snure) × Darke Co. Mam	69.25	3,820	+5.55	+5.36	22.90

*Ear-corn 15% moisture.

In 1914, 4 crosses were tested. Three of these are better than either parent and one is intermediate. Only one of the 3 superior crosses is advantageous. Of the 13 crosses tested by the side of both parents, 2, only can be said to be of advantage, namely, Reid by Darke Co. Mammoth, and White Cap (Snure's), also by Darke Co. Mammoth.

The yields recorded are of shelled corn as shelled and weighed in April, except for 1914. The percentage of moisture in the ear corn in November will give a little information as to the comparative maturity of crosses and parent varieties.

23—VALUE OF THE GERMINATION TEST

Work was started in 1911, the object of which was to determine the amount of gain, if any, that may be expected under field conditions from the use of seed having perfect germination as judged by the so-called germination test.

One hundred ears were taken at random from a rack on which the corn had been stored since husking time. Throughout the period of storage, conditions were ideal for the free circulation of air around each ear, but no artificial heat was employed in drying. From each of the 100 ears a few kernels were shelled off and the lot of seed thus formed was labeled as "untested" seed. Then, all the ears were given a germination test and from each of those showing perfect germination a few kernels were shelled and the sample labeled as "tested" seed. It will be noted that all the ears represented in the tested lot are included also in the untested.

These two lots of seed were planted on plots side by side and in duplicate. To insure an even stand the kernels were dropped by hand.

Since 1911 the test has been conducted in the same manner with the exception that the seed has been taken not from a seed storage rack but from the middle of a crib—a place probably more like that in which the majority of the farmers are in the habit of keeping their seed.

The percent of germination of seed, the percent of stand obtained in the field and the yield per acre are given for each year in Table XXXII. The tested seed has yielded highest each year but, as might be expected, the amount of gain has varied considerably from year to year depending upon climatic conditions. In 1912 the large gain of 9.27 bushels is probably due to the unusual weather conditions which prevailed during the fall of 1911 and the early winter months of 1912. Heavy rainfall in September and October, 1911;

an unusual number of cloudy, rainy days in the following November and December and a low average temperature for January, 1912, gave rise to conditions most unfavorable for the preservation of seed.

TABLE XXXII: Value of the germination test

Year	Germination of seed		Percent of stand		Bus. shelled corn per acre	
	Untested	Tested	Untested	Tested	Untested	Tested
1911..........	.....	100	73.20	87.80	59.56	62.65
1912..........	75.50	100	58.98	75.64	44.51	53.78
1913..........	97.16	100	92.91	93.35	67.27	68.33
*1914....	93.16	100	79.80	85.45	50.24	52.35
4-yr. average..	88.61	100	76.22	85.56	55.39	59.28

*Ear corn reduced to 15% moisture.

While the gain, as an average of four years, is not great—3.9 bushels—yet, at 50 cents per bushel, it has paid for the time spent in testing the seed at the rate of $6.50 per hour.

24—THINNING CORN

Experiments have been carried on during the past four seasons to determine the advisability of planting liberally and then, later, thinning the plants to the desired stand.

Each year four plots have been planted with untested seed, two by hand and at uniform rate of 3 kernels per hill, and two, alternating with first pair, by planter regulated to drop a generous quantity of seed. After the plants have attained a height of 6 to 8 inches, the latter plots have been thinned to an average stand of 3 plants per hill.

A similar comparison has been made each year with the use of tested seed (untested and tested seed prepared as described in topic 23).

The results of these tests are tabulated in Table XXXIII. In the untested seed the four-year average gain from thinning has been 8.47 bushels per acre. The average time required to thin an acre has been 5.4 hours. Therefore at 50 cents per bushel, the thinning has paid for itself at the rate of 78 cents per hour.

In the tested seed the gain from thinning has been a little less—6.31 bushels per acre, but even this increase, at 50 cents per bushel, affords an hourly wage of 52 cents, the average time required to thin an acre planted with tested seed having been 6 hours.

The large increase from thinning noted in 1912 is due to low vitality of seed caused by the extremely unfavorable weather conditions of the preceding winter.

TABLE XXXIII: Normal vs. thick planting.

Year	Bushels shelled corn per acre			
	Untested seed		Tested seed	
	Planted 3 kernels per hill	Planted thick, later thinned	Planted 3 kernels per hill	Planted thick, later thinned
1911	59.56	63.95	62.65	65.22
1912	44.51	65.35	53.78	69.17
1913	67.21	68.61	68.33	69.39
*1914	50.24	57.50	52.35	58.59
4-year average	55.38	63.85	59.28	65.59

*Ear corn reduced to 15% moisture.

Though thinning is undoubtedly a profitable operation, yet on many farms lack of laborers renders it impracticable.

25—SHRINKAGE IN CORN

To determine the loss of moisture in ear corn month by month throughout the year, 100 pounds were stored in a box on the second floor of a corn crib November 1, 1908, and weighed the first of each month thereafter for a year. The sides and top of box, being made of wire netting, the conditions for drying out were favorable. Work of this kind has been conducted for six years and in Table XXXIV are tabulated the results giving the percent of shrinkage from November 1 to the first of each succeeding month. Barring a few exceptions, the shrinkage for each year has increased gradually, reaching a maximum the first of July, August or September, depending upon climatic conditions. The maximum shrinkage has ranged from 6.50 to 24.75 percent and, as an average of six years, is 19.96 percent. This has occurred August 1. As the cool, moist weather of fall approaches the corn begins to take up moisture, hence the slightly lower percentage of shrinkage in September and October.

Of course the amount of shrinkage that takes place in the course of a year depends largely upon the condition of the corn in the fall. In the above tests the average percent of moisture in the shelled corn as it came from the shock has been 24.29.

In view of the shrinkage, manifestly the price per bushel must increase as the season advances, else loss will be sustained by holding in storage.

Upon the basis of shrinkage given in Table XXXIV the value for each month, equivalent to 50 cents per bushel (70 pounds) November 1, is given in Table XXXV.

TABLE XXXIV: Percent of moisture lost fr.m Nov. 1 to:

Year	December 1	January 1	February 1	March 1	April 1	May 1	June 1	July 1	August 1	September 1	October 1
1908-1909	2.50	2 50	2.10	1.40	2.00	4.00	5.00	5.70	6.50	6.00	6 25
1909-1910	5.50	8.00	9.00	9.25	10.00	17.25	19.50	21.00	22.50	24.00	23.50
1910-1911	2.00	4.00	6.00	8.50	12.50	17.75	23.50	24.75	24.50	21.00	23.25
1911-1912	2.50	4.00	5 25	6 25	8.25	12.00	16.50	17.50	17.00	17.00	16.75
1912-1913	5.75	6.75	8.75	10.50	14.25	18 75	21.75	24.00	24.00	23.75	22.75
1913-1914	4.50	7.25	9.25	11.75	14.00	18.50	23.00	23.25	23.75	23.25	23.50
6-yr. average	3.79	5.42	6.72	8.07	11.37	15.08	18.46	19.62	19.96	19.67	19.25

TABLE XXXV: Value of corn equivalent to 50 cts. per bu. Nov. 1

Nov. 1	Dec. 1	Jan. 1	Feb. 1	Mar. 1	Apr. 1	May 1	June 1	July 1	Aug. 1	Sept. 1	Oct. 1
50.00	51.97	52.87	53.60	54.39	56.41	58.88	61.32	62.21	62.47	62.24	61.92

TABLE XXXVI: Moisture content month by month throughout the year; average of 6 years.

Variety	Nov. 1	Dec. 1	Jan. 1	Feb. 1	Mar. 1	Apr. 1	May 1	June 1	July 1	Aug. 1	Sept. 1	Oct. 1
Mid-season	24.29	20.34	19.73	19.49	18.46	15.45	13.09	11.49	10.24	10.08	10.81	11.13
Late	31.04	23.97	22.98	22.84	21.49	18.08	14.50	12.21	11.11	10.69	11.09	11.68

Each year for the past six years there have been stored in boxes as stated in number 25, two 100-pound lots, the one, a mid-season, the other a late corn, as judged by moisture content. Moisture determinations in triplicate have been made on each sample the first of the month.

The six-year average results of the two classes of corn are tabulated in Table XXXVI.

Though the moisture content of the late maturing corn has exceeded that of the mid-season variety by 6.75 percent, November 1, yet, in the course of the year, both have reached practically the same minimum, and at the same time; the average difference August 1 being only 0.61 percent. If conditions of storage are favorable, under Ohio conditions, it would seem that the minimum moisture content of corn may be regarded as approximately 10 percent.

SUMMARY

1—Comparing a 5-year rotation system with the continuous growing of corn, the former has given an increase of 13 to 14.79 bushels per acre, in spite of the heavier use of manure and fertilizers under continuous culture. Comparing a 5-year with a 3-year rotation, the latter has given an increase of 6 to 8.39 bushels per acre. Comparing a 3-year rotation with continuous cropping, no fertilizers used in either case, the yield of corn from the former is 127 percent greater than the latter, as shown in Table I.

2—The use of phosphorus, alone, in the form of acid phosphate, has increased the yield of corn 8.28 bushels per acre. The use of manure alone has increased the yield 31.27 bushels per acre as an 8-year average. The use of acid phosphate and manure has increased the yield 40.58 bushels, thus leaving 9.31 bushels to be credited to the acid phosphate.

3—On such acid soils as are found on the Station farm at Wooster, one ton of burned lime, or two tons of ground limestone, applied once in 5 years, has increased the yield of corn on an average 7.35 bushels per acre on the fertilized plots reported in Table III, and 8.25 bushels per acre on the unfertilized plots. Taking into consideration all the crops of the rotation the application of lime has been worth, on the average, $14.21 per acre per rotation. The cost of the lime has been $5.00.

4—Comparing very deep plowing with ordinary plowing and with subsoiling, the 5-year average gain for subsoiling has been 2.32 bushels per acre, and for the deep plowing, 0.43 bushel per acre.

5—Plantings of corn made at Wooster from May 4 to 10 have given larger yields of shelled corn per acre than the plantings of other dates, though the moisture content and the shrinkage have been lower for the plantings made from April 24 to 29. Of the plantings of the latter dates, 78.62 lbs. of ears as weighed in November have been required to equal a bushel of shelled corn in April, while of the plantings of June 2 to 6, 91.95 lbs. of ears have been required. The variety of corn and all the conditions of growth except date of planting have been the same.

6—Where the distance between rows, and the number of plants per acre have been the same, one plant every 12 inches has outyielded 3 plants every 36 inches by 4.55 bushels per acre.

7—With hills 42 inches apart each way, the maximum yield of shelled corn, as a 10-year average, has been secured from 4 plants per hill, or 14,220 plants per acre.

8—Nine years' tests of deep (4 inches) as compared with shallow cultivation (1½ inch) show an average gain of 4 bushels per acre in favor of shallow cultivation.

9—Two years' tests of late cultivations of corn with a one-horse cultivator, after two-horse implements had to be discarded, show an average gain of 3.44 bushels per acre for late cultivation.

10—A 10-year average variation of 6.25 bushels per acre has been found in varieties of corn well acclimated to the locality where tested. A variation in yield of 34.29 bushels per acre has been found in varieties grown and sold for seed within the state.

11—A comparison of ears varying 2.44 inches in length, on the average, shows a difference in yield of only 1.39 bushel per acre, as a 10-year average—a difference no greater than might have been expected had the seed used been identical. While there is a slight decrease in length of ear in the short-eared strain, it has not materially affected the yield.

12—As a 9-year average, tapering ears have excelled cylindrical ears in yield by 1.65 bushel per acre.

13—Eight years' continuous selection for bare, as compared with filled tips shows an average difference of 0.34 bushel per acre in favor of filled tips.

14—Comparing rough with smooth dented ears, the 7-year average yield favors the smooth type by a gain of 1.76 bushel per acre.

15—Seed ears averaging 88.16 percent grain have given a 6-year average yield of 64.64 bushels of shelled corn per acre, as compared with a yield of 65.06 bushels from ears averaging 76.38 percent of grain.

16—A comparison of kernels from the butt, middle and tip portions of ears shows only 0.57 of a bushel difference in yield, as a 9-year average, and no difference in maturity or any important character.

17—Seed ears having 14, 16 and 18 rows of kernels have been compared for 5 years. The 14-rowed ears have led slightly in yield at Wooster and Germantown; the 16-rowed ears at Carpenter.

18—While the height of plant and ear varies with the season, selecting for high and low ears within a variety has resulted in changing very materially the relative height of ear and also the time of maturity. Low ears are associated with earliness. The comparative yield has not been reduced by selection for low ears.

19—Seed corn grown on rich, as compared with poor soil, and one plant per hill, as compared with five, though larger and apparently of better quality, has not given any larger yield, on the average, than the smaller ears grown under the poorer conditions.

20—The principal causes of barren plants are variations in season, in fertility and in time and rate of planting. Such variations in conditions of growth have increased the amount of barrenness 200 to 2,000 percent.

21—Ear-row tests and subsequent crossing of the best ears in isolated breeding plots show possibilities of increasing the yield of corn 5 to 10 bushels per acre, but it seems difficult to go much beyond this amount.

22—Of 13 first-generation crosses grown beside both parents, only two exceeded in yield the better parent variety by more than 2 bushels per acre.

23—A 4-year average gain of 3.9 bushels of shelled corn per acre has resulted from the use of the individual ear germination test. At 50 cents per bushel for corn, this is a return of $6.50 per hour for testing.

24—Experiments in thinning corn show a 4-year average gain of 8.47 bushels per acre in the case of untested seed and 6.31 bushels for tested seed. The average time required for thinning an acre of corn has been 5.7 hours.

25—As an average of 6 years' tests corn reached its maximum shrinkage August 1st. Based on shrinkage alone, 62.47 cents for 70 pounds of ear corn August 1st is equivalent to 50 cents November 1st. While mid-season and late varieties had 24.29 and 31.04 percent of moisture, respectively, November 1st, on August 1st they carried 10.08 and 10.69 percent, respectively.